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AMS Emulation Technology

Results From DARPA POSH – Phase 1

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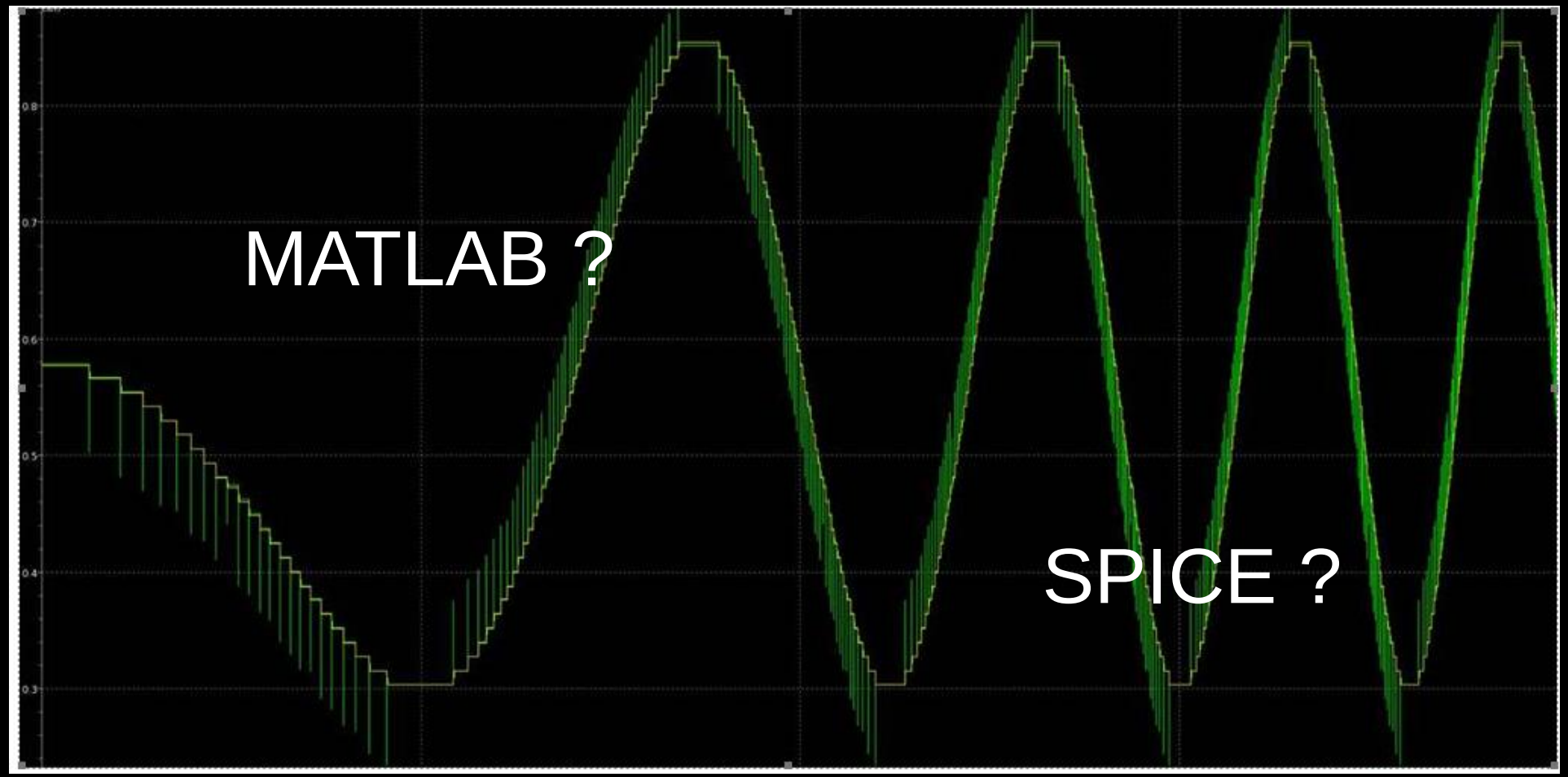
What is this?

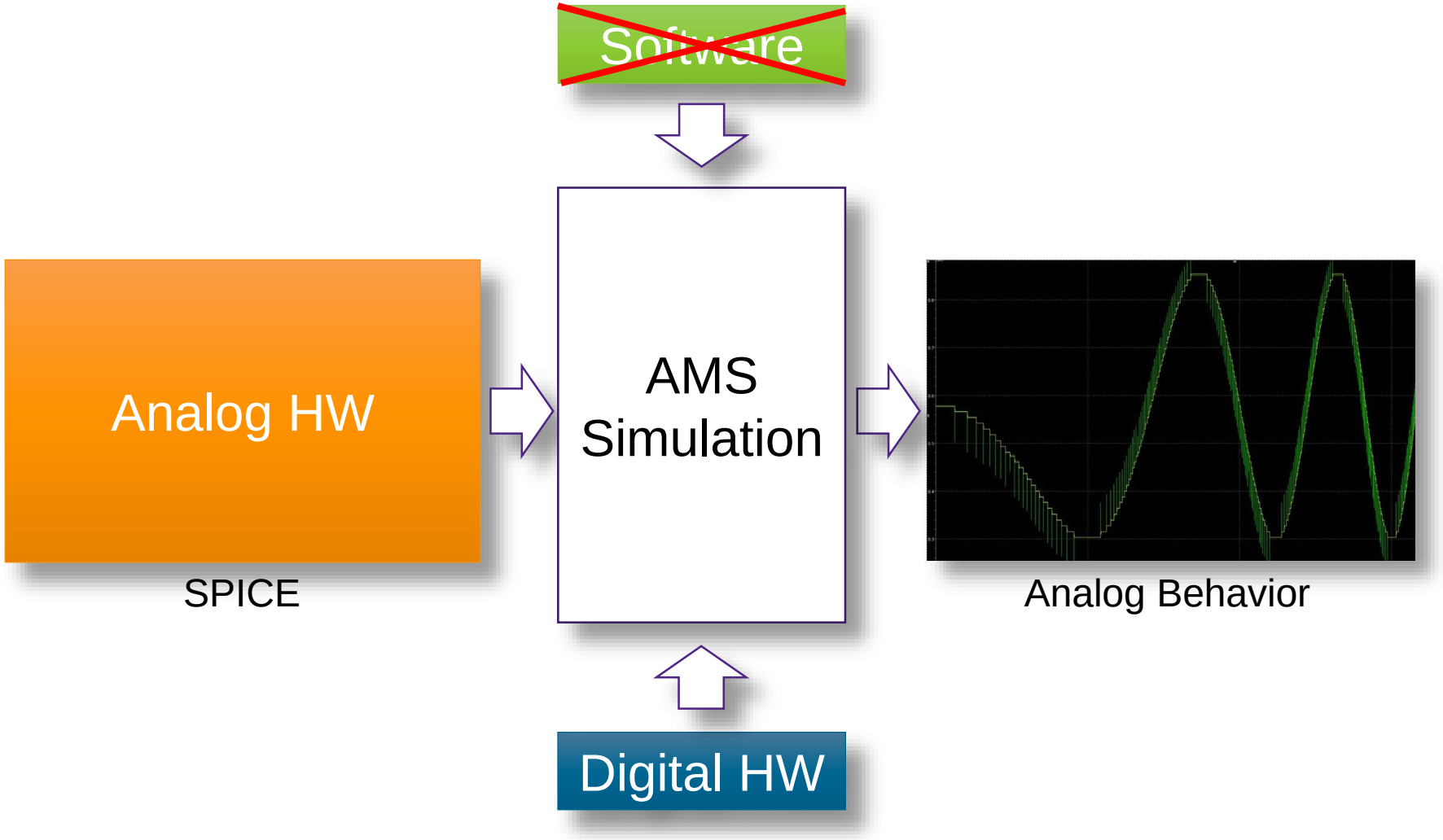


Or ….

AMS Verification Today

Too Slow for Software and System Validation

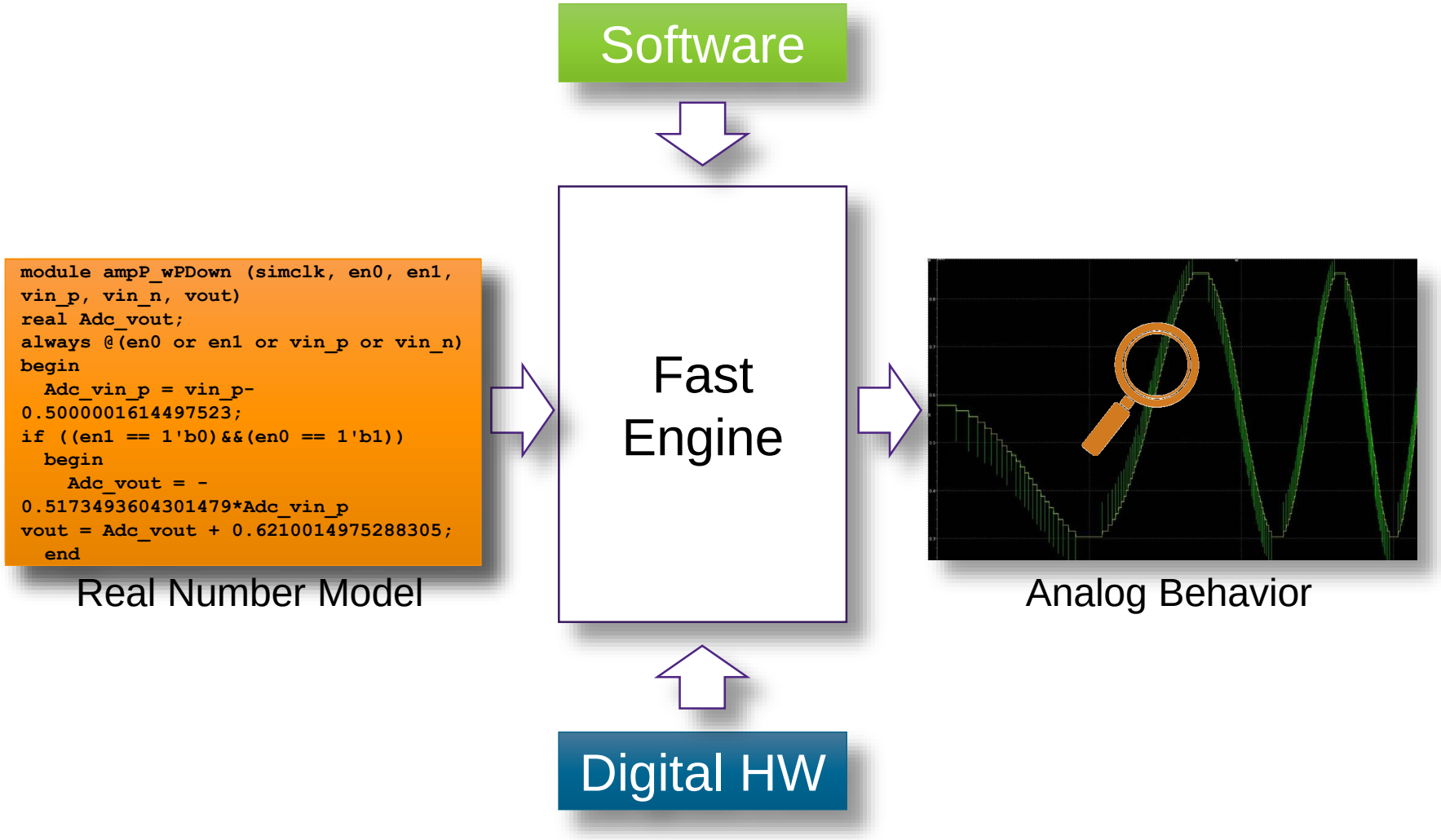
- Engine
  - Analog Mixed-Signal Simulation (SPICE + SV)
- Advantage
  - Accuracy
- Disadvantage
  - Slow



What's Needed

System and Software Validation for AMS Designs

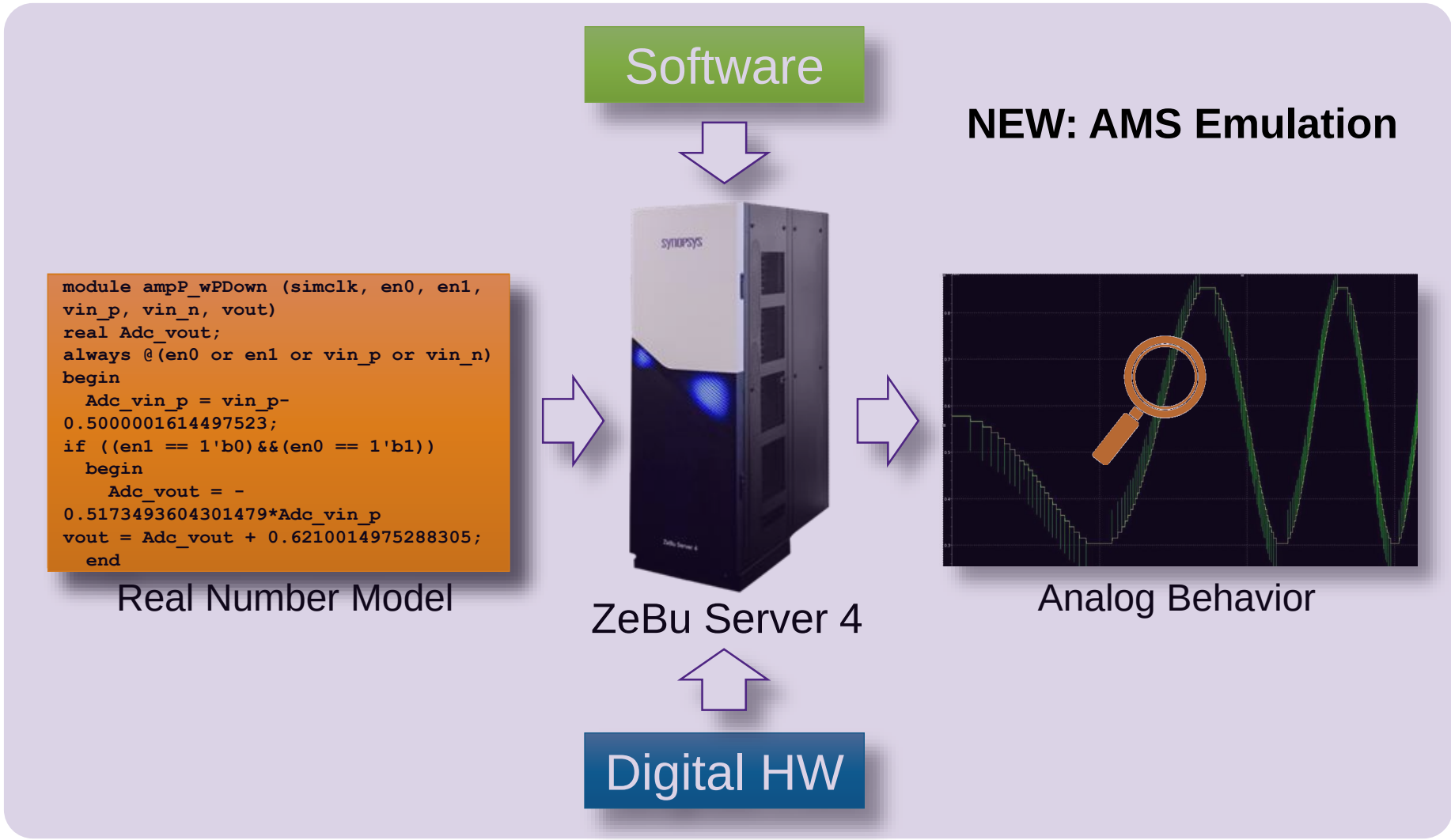
- Engine
  - Ability to execute software workloads
- Modeling
  - Using standard language
- Accuracy
  - Sufficient for system level integration analysis



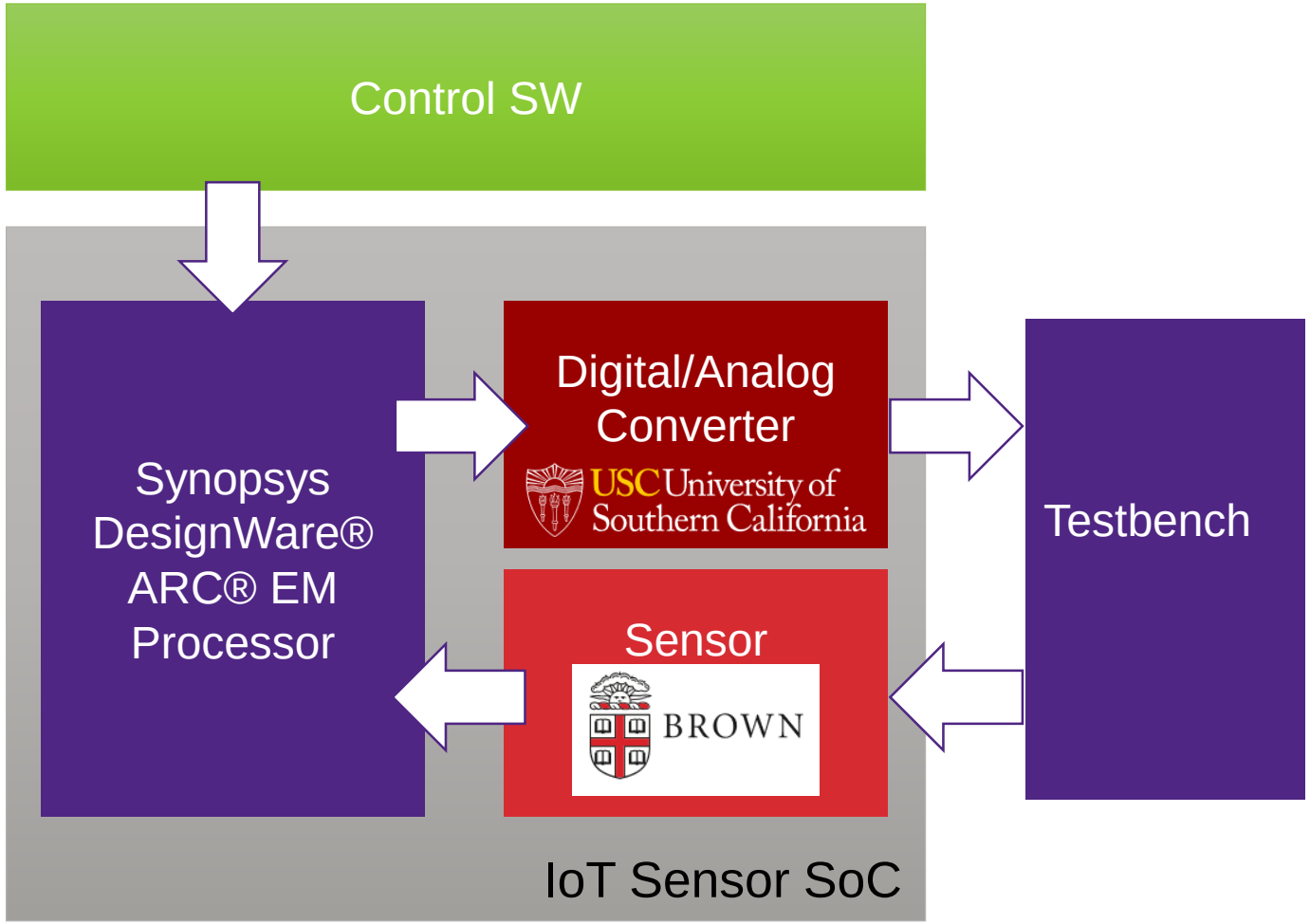
DARPA POSH – Phase 1 Result: AMS Emulation

System and Software Validation for AMS Designs

- Engine
  - Emulation
- Modeling
  - Real Number Model using SV data type
- Accuracy
  - Sufficient for system level integration analysis



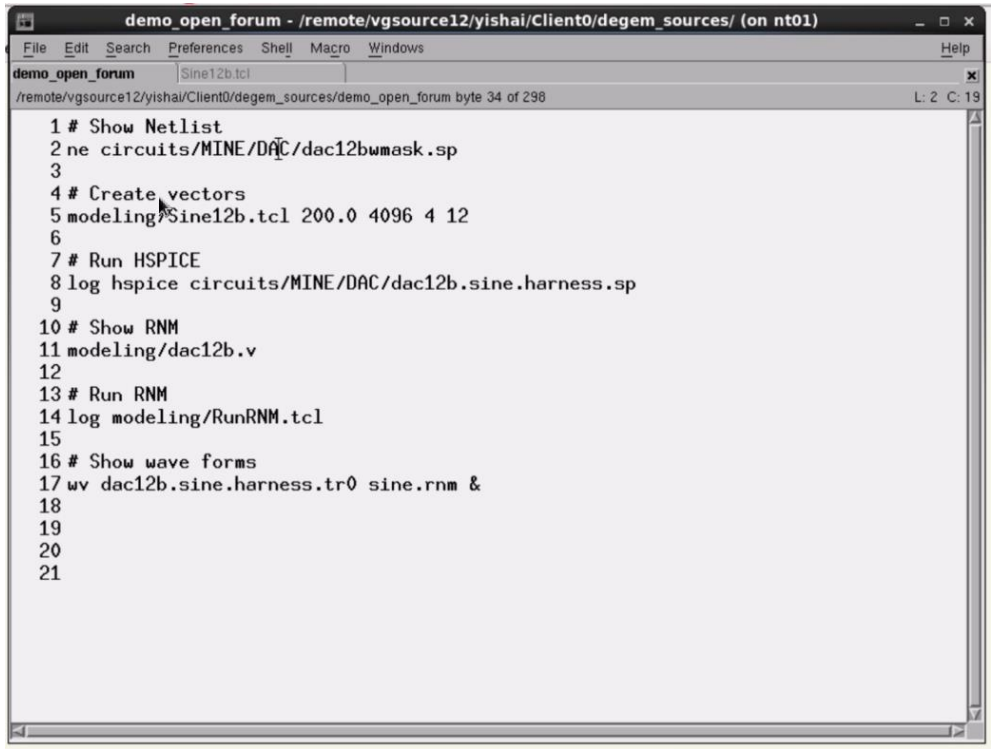
Demo Time: Let's Take a Quick Look



SPICE Conversion to RNM Demonstration (1)

FLOW

We will display the input netlist (a mix of digital and analog content), show how the tool recognizes and separates this content, run SPICE, convert the netlist to RNM and display it (takes only 1 second to simulate RNM vs. 70 for SPICE), and compare the simulation output of SPICE input against RNM output



SPICE Conversion to RNM Demonstration (2)

Snippet of DAC SPICE netlist

dac12bwmask.sp - /remote/vgsource12/yishai/Client0/degem_sources/circuits/MINE/DAC/ (on nt01)

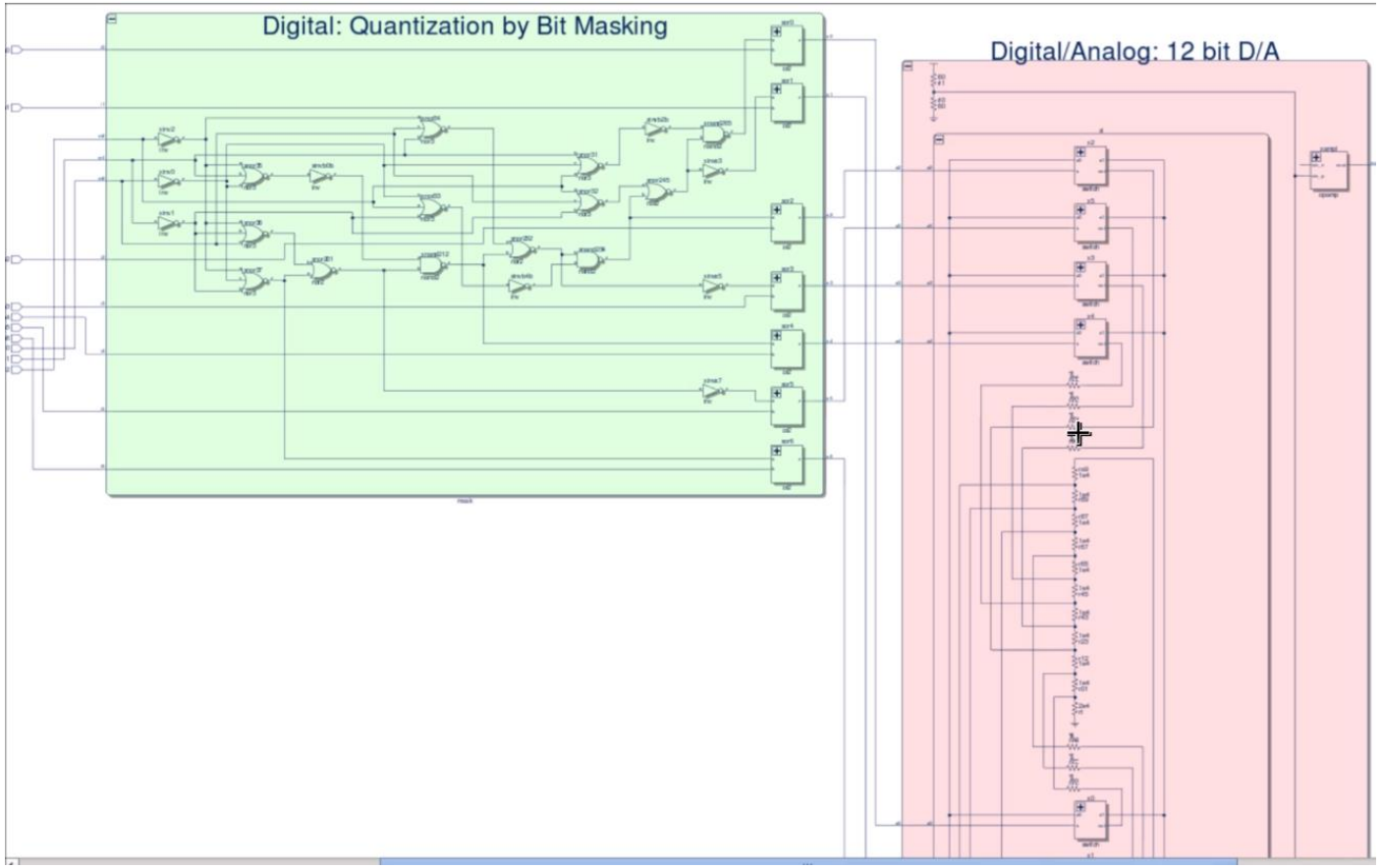
File Edit Search Preferences Shell Macro Windows Help

/remote/vgsource12/yishai/Client0/degem_sources/circuits/MINE/DAC/dac12bwmask.sp byte 0 of 6381 L: 1 C: 0

```
 76 r9 p9 p9t 2e4
 77 ra9 pat p9t 1e4
 78 ra pa pat 2e4
 79 rab pat out 1e4
 80 rb pb out 2e4
 81 .ends
 82
 83 .subckt opamp gnd vdd vin_n vin_p vout
 84 r0 vout vin_n 5e9
 85 r1 ibias net030 1.9141e3 M=1
 86 mt1 net065 vin_p net020 vdd fetp L=1e-6 W=8e-6 AD=2.24e-12 AS=3.84e-12 PD=560e-9
 87 mn1 net020 net085 vdd vdd fetp L=1e-6 W=10e-6 AD=5.6e-12 AS=7.6e-12 PD=1.12e-6 P
 88 mn0 net085 net085 vdd vdd fetp L=1e-6 W=10e-6 AD=5.6e-12 AS=7.6e-12 PD=1.12e-6 P
 89 mt2 vout vin_n net020 vdd fetp L=1e-6 W=8e-6 AD=2.24e-12 AS=3.84e-12 PD=560e-9 P
 90 mp0 ibias ibias gnd gnd fetn L=2e-6 W=10e-6 AD=2.8e-12 AS=4.8e-12 PD=560e-9 PS=2
 91 mp3 net085 ibias gnd gnd fetn L=2e-6 W=10e-6 AD=2.8e-12 AS=4.8e-12 PD=560e-9 PS=
 92 mp2 vout net065 gnd gnd fetn L=2e-6 W=2e-6 AD=560e-15 AS=960e-15 PD=560e-9 PS=4.
 93 mt4 ibias vdd gnd gnd fetn L=1e-6 W=5e-6 AD=1.2e-12 AS=1.2e-12 PD=5.48e-6 PS=5.4
 94 mp1 net065 net065 gnd gnd fetn L=2e-6 W=2e-6 AD=560e-15 AS=960e-15 PD=560e-9 PS=
 95 .ends opamp
 96
 97 .subckt switch s out a0 a1 vdd gnd
 98 xinv s sb vdd gnd inv
 99 mp0 out s a0 vdd fetp L=1e-6 W=40e-6 AD=2.24e-12 AS=3.84e-12 PD=560e-9 PS=16.96e
100 mn0 out sb a0 gnd fetn L=1e-6 W=20e-6 AD=2.8e-12 AS=4.8e-12 PD=560e-9 PS=20.96e-
101 mp1 out sb a1 vdd fetp L=1e-6 W=40e-6 AD=2.24e-12 AS=3.84e-12 PD=560e-9 PS=16.96
102 mn1 out s a1 gnd fetn L=1e-6 W=20e-6 AD=2.8e-12 AS=4.8e-12 PD=560e-9 PS=20.96e-6
103 .ends
```

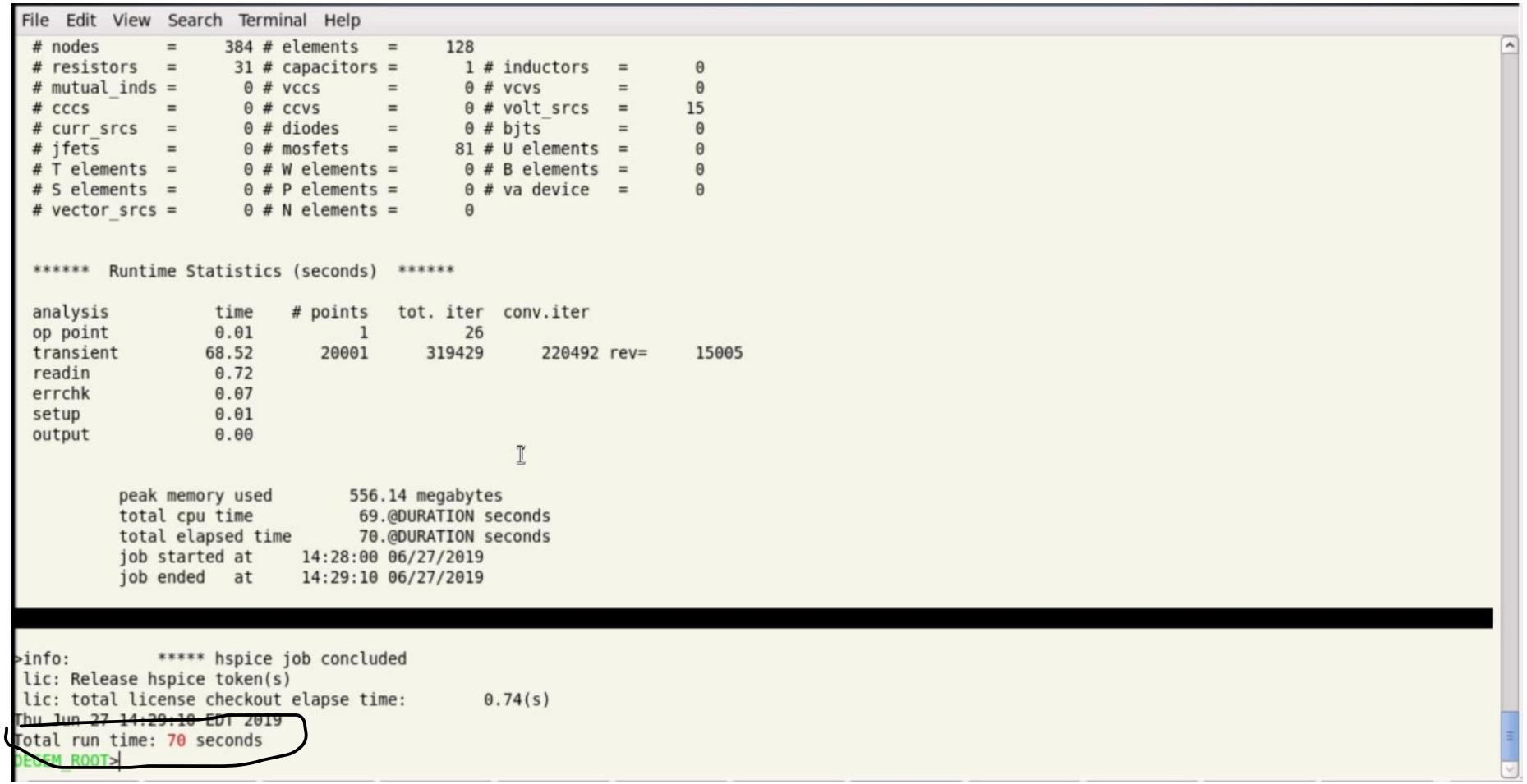
SPICE Conversion to RNM Demonstration (3)

SPICE conversion tool recognizes and separates digital and analog circuits



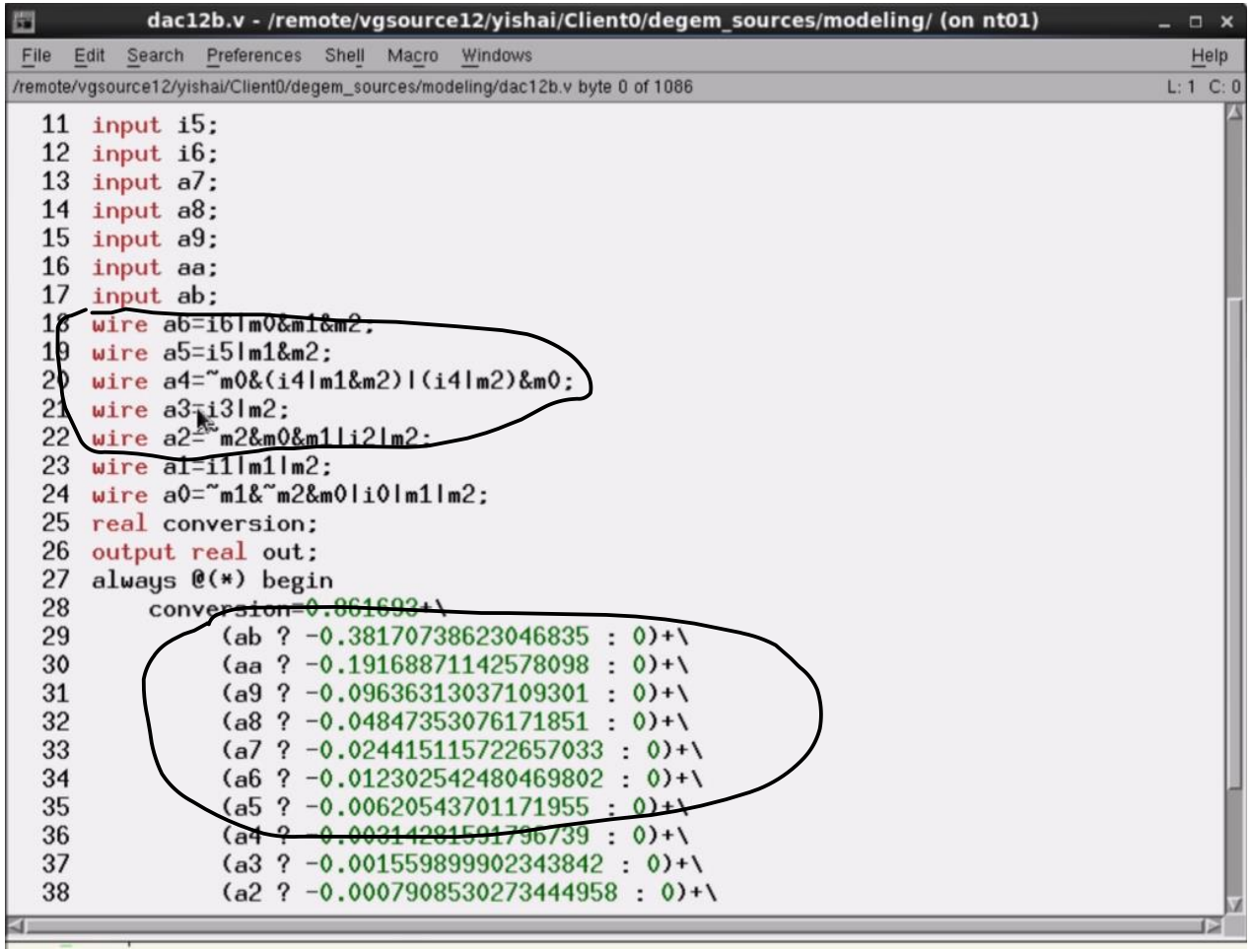
SPICE Conversion to RNM Demonstration (4)

SPICE simulation takes 70 seconds (RNM takes 1 second)



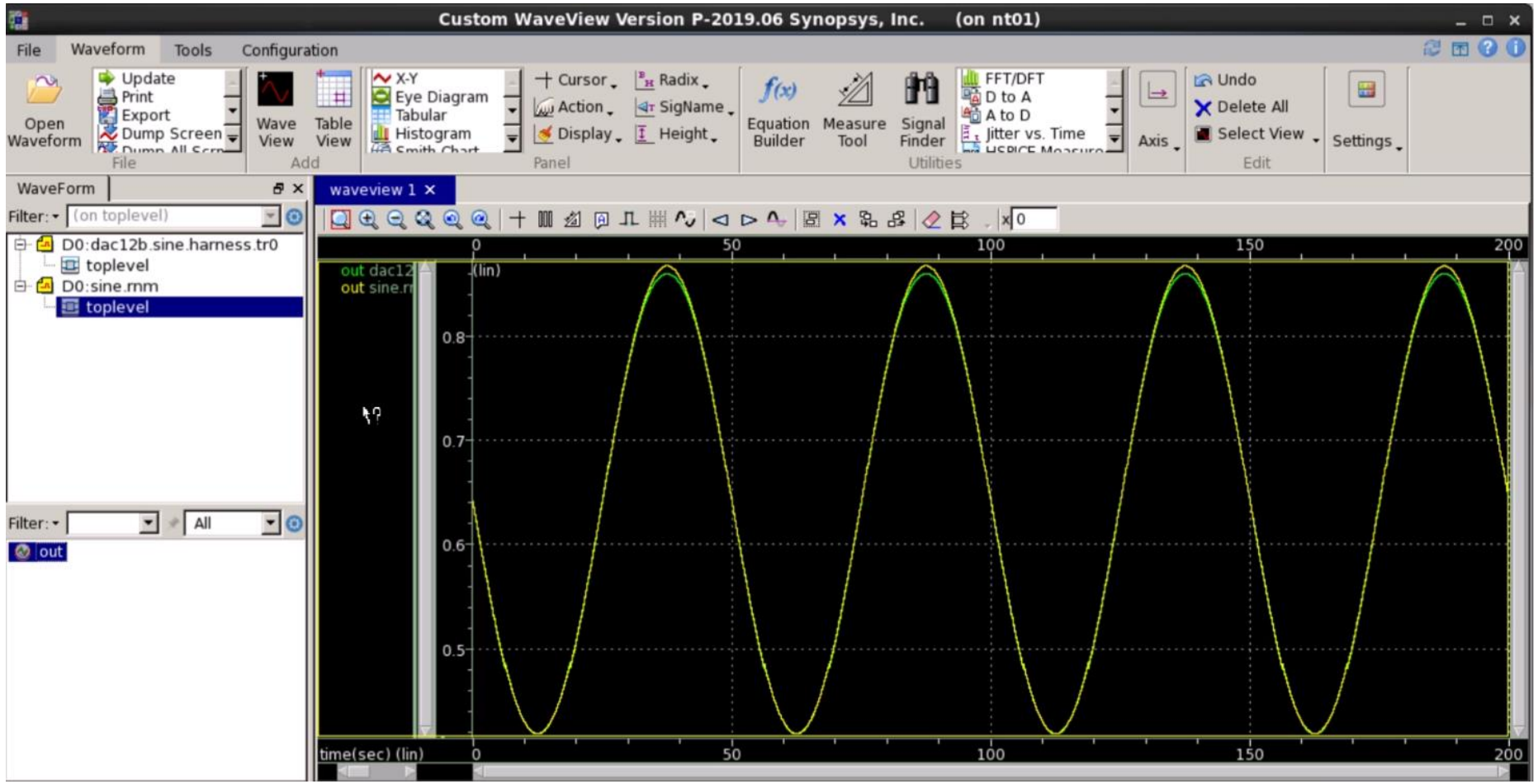
SPICE Conversion to RNM Demonstration (5)

Snippet of RNM generated (note mix of digital Boolean and analog real numbers)



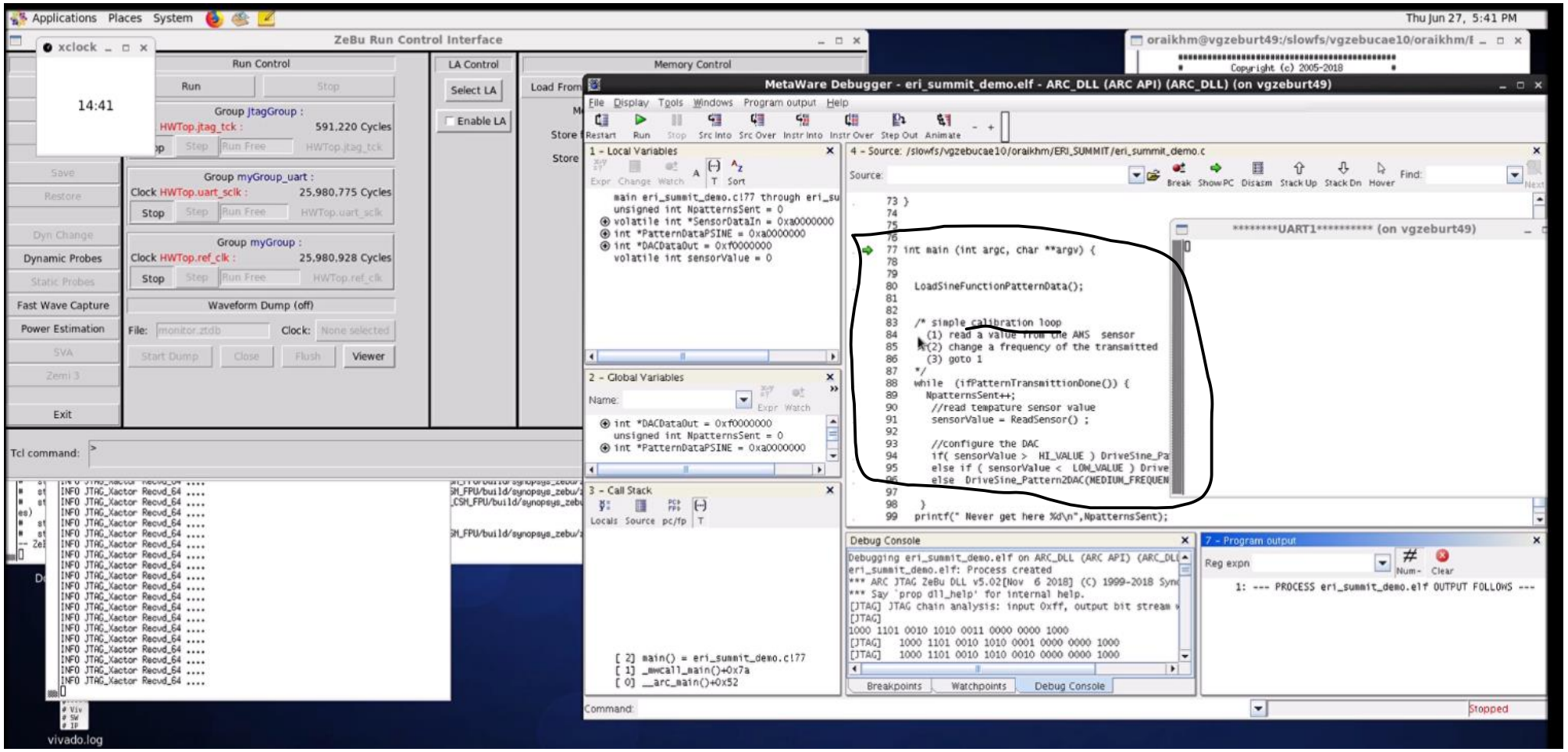
SPICE Conversion to RNM Demonstration (6)

Comparison of SPICE vs. RNM simulation output waveforms



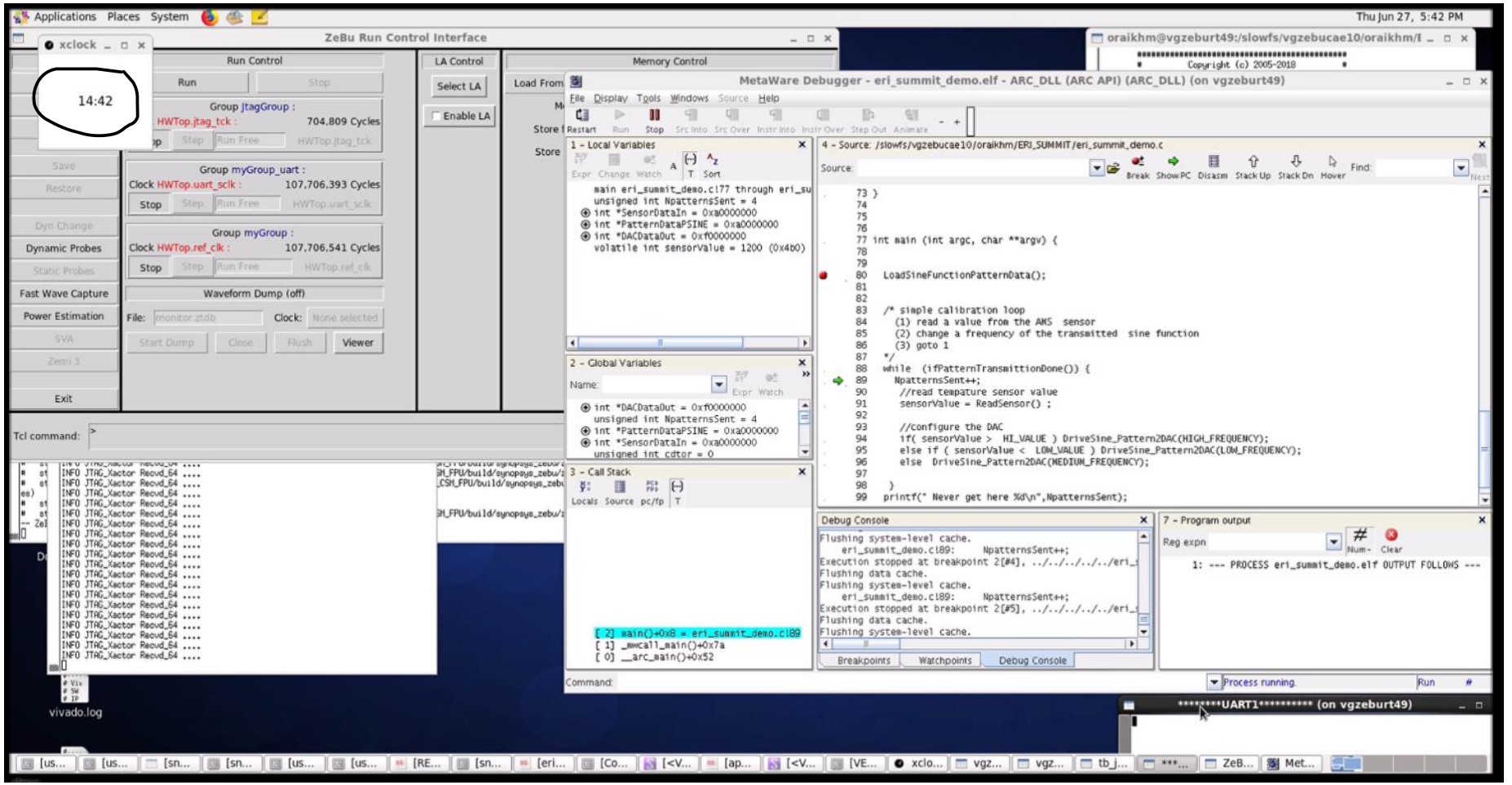
AMS Emulation (1)

Debugger at breakpoint showing calibration software running on ZeBu emulator



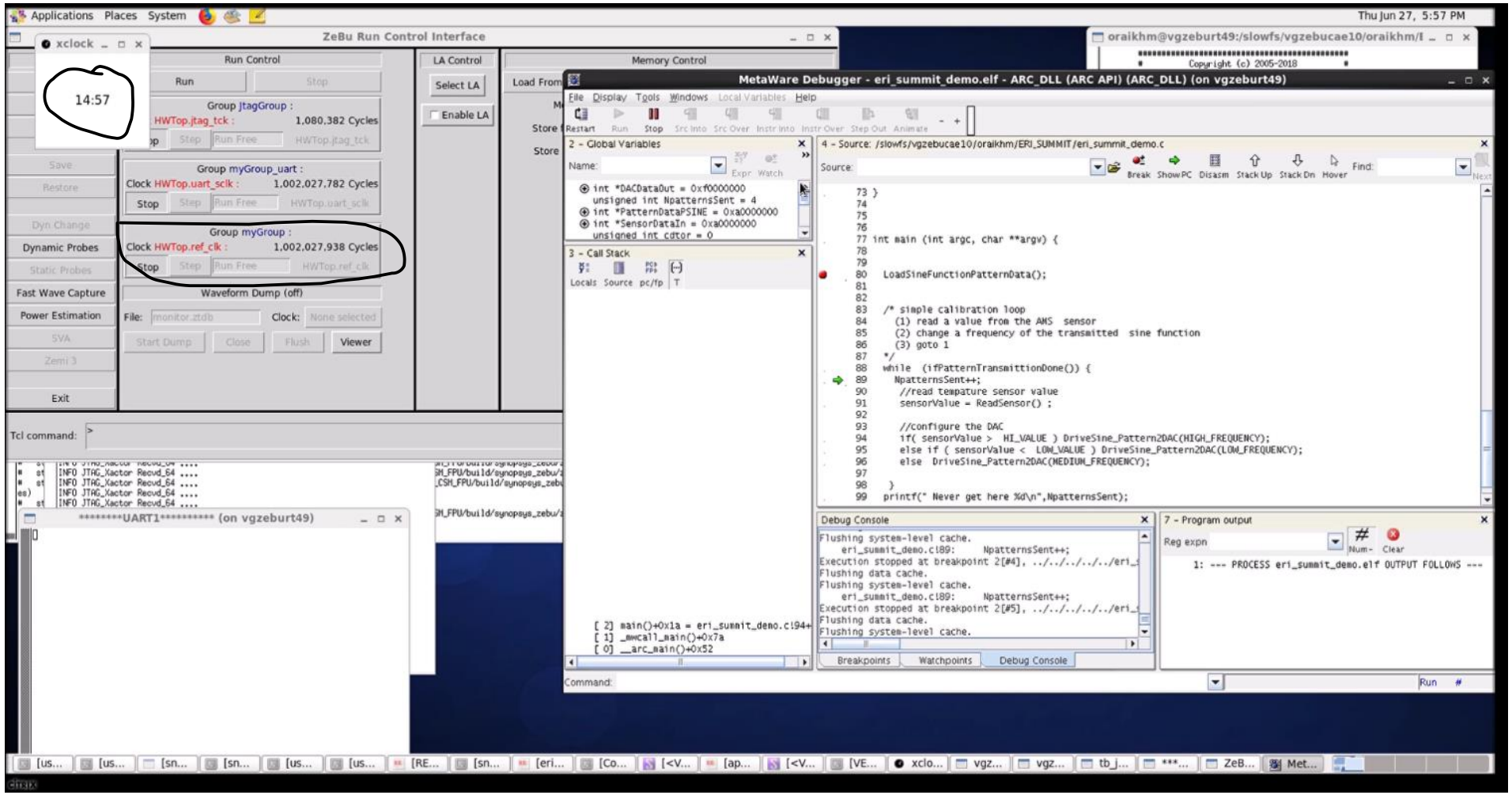
AMS Emulation (2)

At 2:42 PM, remove breakpoint and let emulator run (@ 2 MHz)



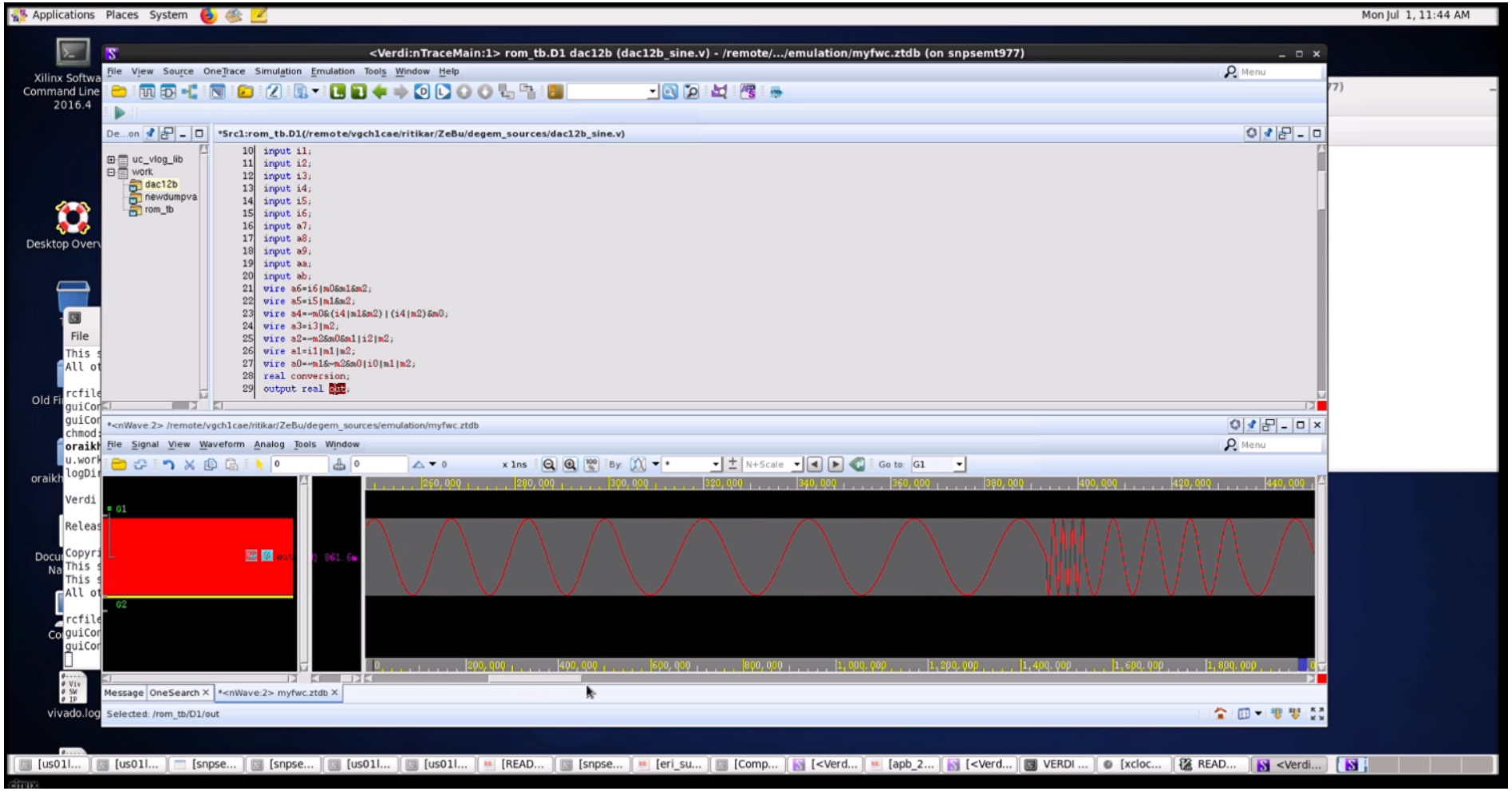
AMS Emulation (3)

At 2:57 PM, 15 seconds later, have already run over one billion cycles



AMS Emulation (4)

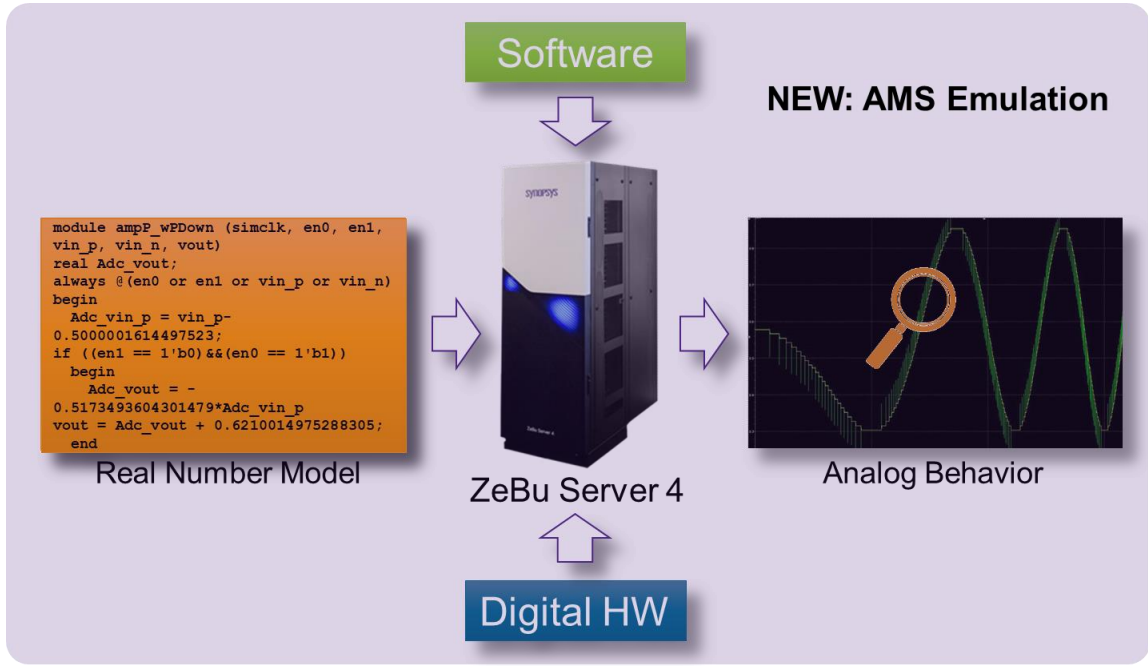
Analog waveform output from simulator shows circuit working



AMS Emulation: Summary and Next Steps

Results From DARPA POSH – Phase 1

- What you saw today
  - AMS emulation is working
  - AMS emulation delivers expected performance
  - Validation of AMS SoC including SW
- Next Steps
  - Continue to optimize AMS emulation technology
  - Enlarge the AMS emulation partner community
  - Develop complementary AMS assertions



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Thank You

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